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Morphological comparisons of brown frogs (genus *Rana*) from Sakhalin, Hokkaido and Primorsk

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One species of brown frog from Sakhalin, previously assigned to *Rana temporaria*, *R. chensinensis* or *R. semiplicata*, is very similar to *R. pirica* from Hokkaido in body coloration and skin texture. However, results of morphometric analyses indicate its intermediate nature between *R. pirica* and *R. dybowskii* from Primorsk. Clarification of the taxonomic status of this frog needs further study from different approaches.

INTRODUCTION

Two species of brown frogs (*Rana temporaria* group of BOULENGER, 1920) occur on Sakhalin island (BANNIKOV et al., 1977). One is unambiguously identified as *Rana amurensis* (BANNIKOV et al., 1977; KUZMIN et al., 1988), but the taxonomic status of the other is at present uncertain. It is usually regarded as *Rana chensinensis* (ORLOVA et al., 1977; KUZMIN et al., 1988) or sometimes as *Rana semiplicata* (BANNIKOV et al., 1977). However, recent taxonomic studies revealed that the Asian brown frogs that have long been collectively treated as *Rana chensinensis* actually include several distinct taxa (for review, see MATSUI, 1991 and MATSUI et al., 1993). As a result, the population of "*Rana* *chensinensis*" from Hokkaido (Kawamura, 1962) was described as *Rana pirica* (Matsui, 1991).

In describing *Rana pirica*, the senior author (Matsui, 1991) restricted the range of this species to Hokkaido, but the close taxonomic relationship of the frogs on Sakhalin and Hokkaido has long been accepted (Okada, 1930, 1931, 1966; Nakamura & Uéno, 1963, 1965), and their taxonomic relationships await clarification. As a part of our studies to determine the taxonomic status of the brown frog from Sakhalin, we compared this population morphometrically with *Rana pirica* from Hokkaido and *R. dybowskii* from Primorsk.

MATERIALS AND METHODS

We examined a total of 71 preserved specimens of *Rana pirica* from Hokkaido (40 males and 31 females), 37 specimens of *Rana* sp. from Sakhalin (31 males and 6 females; fig. 1) and 20 specimens of *Rana dybowskii* from Primorsk (15 males and 5 females) (Appendix I). Seventeen body measurements were taken (Table I), mostly following Matsui (1984). Briefly, they are: (1) snout-vent length (SVL); (2) head length (HL); (3) head width (HW); (4) snout length (SL); (5) snout height (SH = height of snout, measured at the level of the anterior corner of the eye, including the lower jaw); (6) intercanthal distance (ICD); (7) eye length (EL); (8) tympanum diameter (TD = greatest diameter); (9) internarial distance (IND); (10) interorbital distance (IOD); (11) upper eyelid width (UEW); (12) lower arm length (LAL); (13) hindlimb length (HLL); (14) thigh length (THIGH); (15) tibia length (TL); (16) foot length (FL); (17) inner metatarsal tubercle length (IMTL). All measurements were made to the nearest 0.1 mm with dial calipers. For morphometric comparisons, only sexually mature adults were used, and males and females were analyzed separately.

In order to examine interspecific and intersexual variation in each character dimension, analysis-of-covariance (ANCOVA) procedure was performed using SVL as the covariate. All measurements were log-transformed in this procedure. Each character dimension was then converted to a percentage ratio to SVL for further comparisons. For these ratio variables and frequency data for degree of toe webbing and position of tibio-tarsal articulation, Kruskal-Wallis tests with nonparametric multiple comparisons, Wilcoxon rank sum tests, or Mann-Whitney's U-tests were performed to detect the presence or absence of differences in the frequency distributions. The significance level was set at 0.05.

Programs designed and implemented by the S.A.S. (1989) package were used in the multivariate analyses. The analyses were performed through the facilities of the Data Processing Center, Kyoto University. A canonical discriminant analysis, performed by the CANDISC procedure was conducted and canonical variate scores of individuals were plotted on their respective axes. Further, a discriminant analysis (DISCRIM) was used to assess the degree with which each individual specimen was correctly classified into its home group.

Table I. - SVL ($\bar{x}$ ± 1 SE, followed by ranges in parentheses, in mm) and percentage ratios of each character dimension to SVL (medians, followed by ranges in parentheses) in brown frogs. See text for abbreviations.

	Males			Females		
	R. pirica (n = 40)	*Rana* sp. from Sakhalin (n = 31)	*R. dybowskii* (n = 15)	*R. pirica* (n = 31)	*Rana* sp. from Sakhalin (n = 6)	*R. dybowskii* (n = 5)
SVL	53.6 ± 0.7 (44.1-62.9)	54.6 ± 0.8 (39.7-60.8)	56.1 ±1.2 (50.9-67.4)	62.6 ± 0.9 (50.7-74.2)	62.8 ± 2.2 (56.3-71.4)	68.5 ± 1.9 (64.6-74.2)
HL/SVL	33.4 (31.1-35.7)	33.4 (31.1-35.8)	33.3 (31.5-35.7)	32.6 (30.0-37.1)	31.5 (25.6-33.2)	31.7 (30.0-34.2)
HW/SVL	32.1 (29.9-35.7)	33.7 (31.7-35.6)	34.1 (29.8-36.8)	32.3 (29.4-35.8)	33.3 (28.2-33.8)	32.6 (30.6-33.4)
SL/SVL	13.3 (11.5-14.4)	13.5 (11.9-14.9)	13.7 (12.9-15.3)	12.4 (10.7-13.3)	12.8 (12.4-13.4)	13.3 (12.6-14.7)
SH/SVL	9.8 (8.5-11.2)	9.6 (8.3-11.0)	9.5 (8.7-11.5)	10.3 (8.7-11.8)	10.1 (8.7-10.8)	9.8 (9.3-10.2)
ICD/SVL	12.8 (11.1-14.0)	12.2 (10.7-13.8)	11.9 (10.4-13.1)	11.8 (8.9-13.6)	12.0 (11.0-12.4)	11.4 (10.9-12.9)
EL/SVL	9.9 (8.2-11.7)	10.0 (8.6-10.8)	9.9 (9.4-11.3)	8.5 (7.7-9.7)	9.4 (8.3-9.8)	8.8 (8.7-10.6)
TD/SVL	6.5 (5.5-8.7)	6.7 (5.5-7.8)	7.0 (6.1-8.3)	6.2 (4.9-7.3)	6.4 (6.3-6.7)	6.9 (6.0-7.4)
IND/SVL	7.5 (6.3-8.6)	7.7 (6.9-8.3)	7.0 (6.3-7.5)	7.2 (6.1-8.5)	7.2 (6.7-7.8)	6.6 (6.3-7.3)
IOD/SVL	7.0 (6.4-8.1)	6.6 (5.2-8.1)	6.8 (6.2-7.5)	6.4 (4.8-8.0)	6.2 (6.2-6.7)	6.6 (6.5-7.4)
UEW/SVL	7.6 (6.6-9.4)	8.3 (7.2-9.5)	7.5 (6.7-8.3)	7.1 (5.8-8.8)	8.0 (7.6-8.8)	7.2 (7.0-8.2)
LAL/SVL	48.6 (44.1-52.7)	48.9 (46.7-53.1)	47.0 (44.0-50.8)	46.3 (41.9-49.8)	45.1 (43.8-46.1)	42.1 (40.6-44.7)
HLL/SVL	172.3 (161.9-181.9)	172.6 (160.0-186.2)	179.1 (165.2-191.3)	157.9 (141.0-170.2)	161.0 (155.0-163.1)	169.6 (159.9-172.4)
THIGH/SVL	48.5 (45.5-51.9)	48.9 (45.9-52.1)	50.2 (45.3-54.9)	46.7 (42.0-50.0)	46.2 (45.4-46.8)	47.7 (45.7-49.9)
TL/SVL	50.9 (47.8-54.6)	51.5 (48.7-54.4)	53.7 (49.8-59.1)	47.9 (42.0-52.2)	47.6 (46.9-48.8)	51.8 (48.9-54.3)
FL/SVL	57.0 (51.5-61.2)	58.3 (53.7-63.2)	60.5 (56.3-67.0)	51.6 (45.9-55.9)	53.1 (51.7-55.6)	54.1 (52.6-57.0)
IMTL/SVL	5.6 (4.7-7.0)	6.0 (5.0-7.1)	5.8 (4.3-6.7)	5.1 (3.9-5.9)	5.8 (5.6-6.2)	5.8 (5.3-6.6)

Table II. - Variation in the point reached by the tibio-tarsal joint when the hindlimb is bent forwards along the body in brown frogs. Figures indicate the number of specimens (percentage frequency in parentheses).

Species and sex	Position of joint			
	Tip of snout or forward	Anterior edge of eye to snout	Posterior to anterior edge of eye	Posterior edge of eye or behind
Males				
R. pirica	0	8 (20.0 %)	32 (80.0 %)	0
Sakhalin	1 (3.2 %)	6 (19.4 %)	24 (77.4 %)	0
R. dybowskii	0	11 (73.3 %)	4 (26.7 %)	0
Females				
R. pirica	0	0	22 (71.0 %)	9 (29.0 %)
Sakhalin	0	0	4 (100 %)	0
R. dybowskii	0	4 (80.0%)	1 (20.0 %)	0

RESULTS

GENERAL CHARACTERISTICS OF *RANA* SP. FROM SAKHALIN

Morphometric data for *Rana* sp. from Sakhalin are summarized in Table I together with those for the other two species. Females of *Rana* sp. from Sakhalin are significantly larger in SVL ($\bar{x} \pm 1$ SE = 62.8 ± 2.2 mm) than males ($\bar{x} \pm 1$ SE = 54.6 ± 0.8 mm; t-test, $p < 0.001$). Lengths relative to SVL of EL, HL, SL, TD, IND, LAL, HLL, THIGH, TL, and FL were significantly greater in males (Mann-Whitney's U-test, two-tailed, $p < 0.05$). Nearly half of these characters are those of hindlimbs. Thus, when the hindlimb was bent forward along the body, the tibio-tarsal joint reached the point beyond the anterior edge of eye in about one-fourth of the males, but the joint at most reached the anterior edge of eye in females (Table II), though a significant statistical difference was not detected between the sexes (Wilcoxon rank sum test, two-tailed, $p > 0.05$).

Also, males of *Rana* sp. from Sakhalin tended to have slightly more developed toe webbing than females (Table III), but, probably due to the small sample size of females, significant sexual difference was detected only in the inner web of the second toe (Wilcoxon rank sum test, two-tailed, $p < 0.05$).

GENERAL COMPARISONS OF *RANA* SP. FROM SAKHALIN WITH THE OTHER SPECIES

In general appearance, the *Rana* sp. from Sakhalin (fig. 1) more resembled *Rana pirica* than *Rana dybowskii*. *Rana* sp. from Sakhalin shared with *R. pirica* the following characteristics that were different from *R. dybowskii*: thick dorsolateral fold; occasionally

Table III. - Variation in the degree of toe webbing in brown frogs, expressed by the phalanges free of broad web. Figures indicate the number of specimens. in: inner web; out: outer web. Bold characters indicate the position of median.

Position of toe	Phalanx	*Rana* sp. from Sakhalin		*R. pirica*		*R.dybowskii*	
		Males	Females	Males	Females	Males	Females
1 out	0.5	4	0	11	0	2	0
	1	**27**	**6**	**25**	**28**	**13**	**4**
	1.5	0	0	4	3	0	0
2 in	1	0	0	1	0	0	0
	1.5	**20**	1	10	1	5	2
	2	11	**5**	**26**	**29**	**10**	2
	2.5	0	0	3	1	0	0
2 out	0.5	**16**	1	16	6	**12**	**3**
	1	15	**5**	**22**	**25**	3	1
	1.5	0	0	2	0	0	0
3 in	1.5	2	0	0	0	0	0
	2	**27**	**5**	19	15	**13**	2
	2.5	2	1	**21**	**16**	2	2
3 out	0.5	13	1	4	0	2	0
	1	**18**	**5**	**35**	**29**	**13**	**3**
	1.5	0	0	1	2	0	1
4 in	1.5	1	0	0	0	0	0
	2	**21**	3	7	4	**11**	1
	2.5	8	3	**31**	**25**	4	**3**
	3	1	0	2	1	0	0
4 out	1	3	0	2	0	1	0
	1.5	**18**	3	5	2	**9**	1
	2	10	3	**32**	**22**	5	**3**
	2.5	0	0	1	6	0	0
5 in	0	2	0	0	0	0	0
	0.5	**23**	**4**	**22**	12	**12**	**4**
	1	5	2	18	**17**	3	0
	1.5	0	0	0	1	0	0

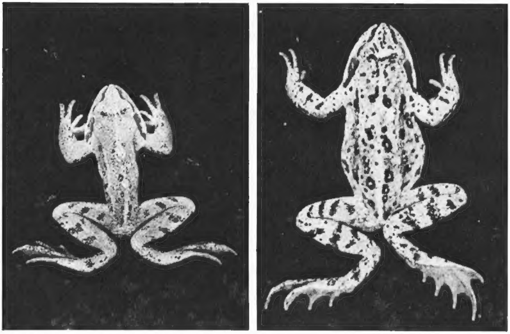

Fig. 1. — Dorsal view of a male (left: KUHE 11623, SVL = 58.1 mm) and a female (right: KUHE 11649, SVL = 71.4 mm) of *Rana* sp. from Sakhalin, Russia.

presence of partial, light stripe on middorsal line; usually presence of heavy dark markings covering the abdomen; dorsal skin with a few tubercles; ventral skin rugose; usually presence of a few dark spots on flanks.

In *R. dybowskii*, in contrast, the dorsolateral fold is usually thin; the light stripe on middorsal line is rarely present; dark markings on abdomen are absent or limited, even if present; the dorsal skin is nearly smooth; the ventral skin is smooth; dark spots on flanks are usually absent.

The degree of development of the outer metatarsal tubercle varied within each species, but the tubercle was less frequently present in *Rana* sp. from Sakhalin than in *R. pirica* or *R. dybowskii*. In *Rana* sp. from Sakhalin, the outer metatarsal tubercle was present only in 25 % of the specimens examined, whereas in both *R. pirica* and *R. dybowskii*, about 70 % of the specimens possessed the tubercle.

In males, *Rana* sp. from Sakhalin did not differ from *R. pirica*, but both of them are significantly different (nonparametric multiple comparison test, $Q_{cal} > Q_{0.05,\ 3} = 2.39$) from *R. dybowskii* in the position of the tibio-tarsal joint (Table II). Females showed a similar tendency, but the difference was not significant. On the contrary, *Rana* sp. from Sakhalin more closely resembled *R. dybowskii* than *R. pirica* in the degree of toe webbing (Table III). In males, *Rana* sp. from Sakhalin had more developed webbing than *R. pirica* in the inner webs of the second, third, and fourth toes and outer webs of the third and fourth toes, but from *R. dybowskii* it differed only in the inner web of the second toe. In females, significant difference was found only in the outer web of the fourth toe between *Rana* sp. from Sakhalin and *R. pirica*.

UNIVARIATE COMPARISONS

Results of ANCOVA showed that all characters, except for IOD in *Rana* sp. from Sakhalin and IMTL in *R. dybowskii*, had significant correlations with SVL in males. On the contrary, many characters (HL, SH, EL, IND, IOD, UEW, LAL, HLL and FL in *Rana* sp. from Sakhalin, HL, HW, SL, ICD, EL, TD, IND, IOD, LAL, HLL, THIGH, TL, FL and IMTL in *R. dybowskii*, and UEW in *R. pirica*) showed insignificant correlations with SVL in females, probably due to the small sample size and small variation range in each sample. Significant deviation of the slope (α) from 1 (isomorphic relationship: MATSUI, 1984) in the regression line was observed in some cases. In males, SL, IND, LAL, THIGH and TL (fig. 2) in *Rana* sp. from Sakhalin, HL, HW, EL, IOD and LAL in *R. pirica*, and HW and LAL in *R. dybowskii*, were all bradymorphic ($\alpha < 1$) to SVL. On the other hand, HL, SL, SH, EL, UEW, HLL, THIGH and TL in *R. pirica* and SH in *R. dybowskii* were bradymorphic to SVL, but UEW in *R. dybowskii* was tachymorphic ($\alpha > 1$) to SVL in females. All the other regression lines significantly correlated to SVL were insignificantly different from 1 in coefficient of the slope.

Among the three species, differences in the slope of regression lines were found only in EL and THIGH in males. In EL, the slope in *R. dybowskii* was steeper than that of *Rana* sp. from Sakhalin, which in turn was steeper than the slope of *R. pirica*. On the other hand, the slope of THIGH in *R. pirica* was steeper than that of *R. dybowskii*, which in turn was steeper than that of *Rana* sp. from Sakhalin. By contrast, much more numerous differences were found among the three species in the position of the regression lines. In males, HW, SL, ICD, IND, IOD, UEW, HLL, THIGH, TL, FL and IMTL were found to differ in some combinations among the three species. Similarly, the position of the regression lines for HL, SL, EL, UEW, HLL, TL and IMTL differed in females, but, as noted above, these characters insignificantly correlated to SVL in one or two of the three species.

In this way, the results of ANCOVA were rather complex, and particularly in females, neither significant correlation of regression lines nor deviation from 1 in regression lines were observed in many cases. Therefore, the relative sizes of morphometric characters were simply expressed by percentage ratios to SVL. As a result, many characters showed significant differences ($Q_{cal} > Q_{0.05,\ 3} = 2.39$) among the three species.

Rana sp. from Sakhalin differed from *R. pirica* in seven of 16 characters compared: two characters in both sexes, four in males, and one in females. In both sexes, *Rana* sp. from Sakhalin had larger relative values in UEW (males: Q = 4.04; females: Q = 2.95) and IMTL (males: Q = 2.93; females: Q = 3.35) than *R. pirica*. Males of *Rana* sp. from Sakhalin had larger relative HW (Q = 4.08) and FL (Q = 2.99), and smaller ICD (Q = 2.49) and IOD (Q = 3.89) than *R. pirica*. Females did not differ in these characters, but *Rana* sp. from Sakhalin had larger EL (Q = 2.45) than *R. pirica*.

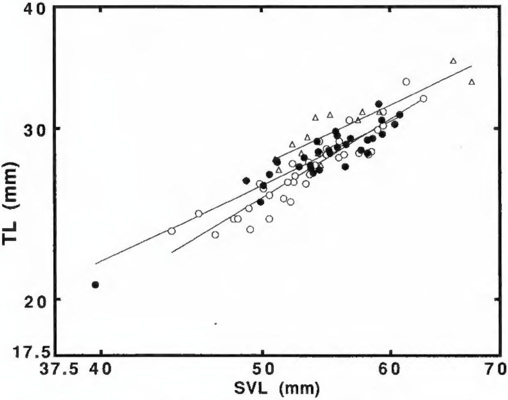

Fig. 2. – Allomorphic relationships between SVL and tibia length (TL) in males of *Rana* sp. from Sakhalin (closed circles: regression equation, log TL = 0.850 log SVL −0.027, r = 0.931), *R. pirica* (open circles: log TL = 1.010 log SVL − 0.310, r = 0.927) and *R. dybowskii* (open triangles: log TL = 0.768 log SVL + 0.135, r = 0.894).

In five (one character in both sexes and four in males) out of 16 characters compared, *Rana* sp. from Sakhalin differed from *R. dybowskii.* Both sexes of *Rana* sp. from Sakhalin had smaller value in TL (males: Q = 3.08; females: Q = 2.51). Also, males of *Rana* sp. from Sakhalin had larger IND (Q = 4.23) and UEW (Q = 3.36), and smaller HLL (Q = 2.43) and THIGH (Q = 2.66) than male *R. dybowskii* (fig. 3), but females did not differ in these characters.

The difference between *R. pirica* and *R. dybowskii* was the greatest and they differed in 11 out of 16 characters compared: four characters in both sexes, five in males, and two in females. In both sexes, *R. pirica* was smaller in TL (males: Q = 4.25; females: Q = 2.94), HLL (males: Q = 3.27; females: Q = 3.01), FL (males: Q = 4.28; females: Q = 2.51) and SL (males: Q = 2.45; females: Q = 2.74) than *R. dybowskii.* In males, *R. pirica* was larger in IND (males: Q = 3.92) and ICD (Q = 3.31), but was smaller in THIGH (Q = 2.44), HW (Q = 4.11), and TD (Q = 2.93) than *R. dybowskii*, while in females, *R. pirica* was larger in LAL (Q = 3.11) and smaller in IMTL (Q = 2.90) than *R. dybowskii.*

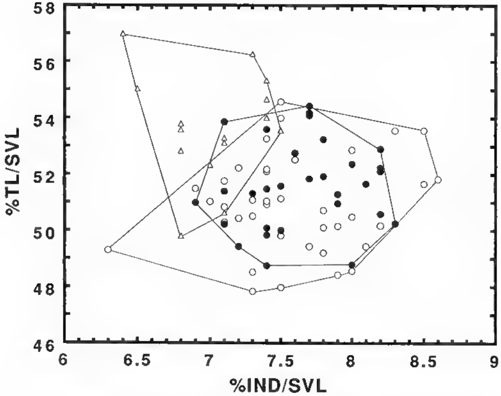

Fig. 3. — Relationships between relative tibia length to relative internarial distance in male samples of *Rana* sp. from Sakhalin (closed circles), *R. pirica* (open circles) and *R. dybowskii* (open triangles).

Thus, *Rana* sp. from Sakhalin is characterized by having a relatively wide upper eyelid and large inner metatarsal tubercle compared with *R. pirica*, and relatively short tibia compared with *R. dybowskii*. In general, these results of univariate analyses, as in those obtained from multivariate analyses, indicated an almost equally great morphological differentiation of *Rana* sp. from Sakhalin from both *R. pirica* and *R. dybowskii*, but the degree of differentiation is small compared with the greater difference between the latter two species.

MULTIVARIATE COMPARISONS

Results from the CANDISC are presented in fig. 4. In both sexes, all F values from the four criteria, e. g., Wilks' Lambda, Pillai's Trace, Hotelling-Lawley Trace, and Roy's Greatest Root Statistics, were significant at $p < 0.0001$, indicating significant geographical effect. In males, the eigenvalue of the first and second axes accounted for 3.453 and 1.379, respectively, and the first canonical variable accounted for 71.5 % of the total amount of

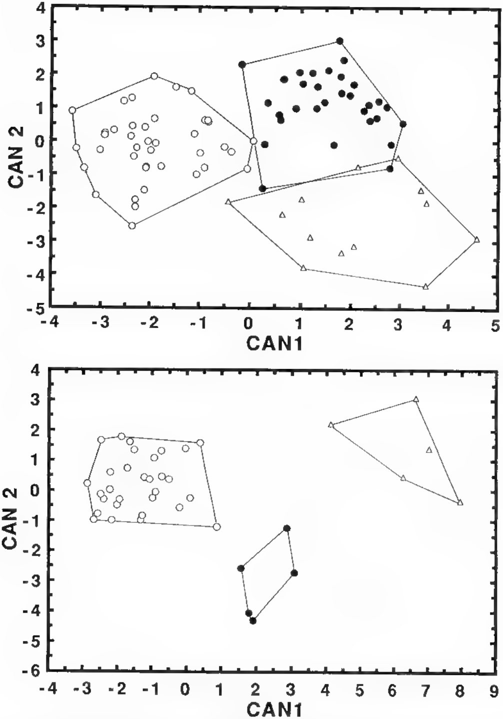

Fig 4. — Plot of first against second canonical variates for samples of *Rana* sp. from Sakhalin (closed circles), *R. pirica* (open circles) and *R. dybowskii* (open triangles). Top, males; bottom, females.

Table IV. - Classification matrix based on linear discriminant function analysis in brown frogs. Entries along the main diagonal are "correct" matches of individuals to their source population.

Actual group	N	Predicted group membership		
		Rana sp. from Sakhalin	*R. pirica*	*R.dybowskii*
Males				
Sakhalin	31	26 (83.9 %)	2 (6.5 %)	3 (9.7 %)
R. pirica	40	3 (7.5 %)	36 (90.0 %)	1 (2.5 %)
R. dybowskii	13	2 (15.4 %)	1 (7.7 %)	10 (76.9 %)
Females				
Sakhalin	5	4 (80.0 %)	0 (0 %)	1 (20.0 %)
R. pirica	31	2 (6.5 %)	28 (90.3 %)	1 (3.2 %)
R. dybowskii	5	1 (20.0 %)	1 (20.0 %)	3 (60.0 %)

eigenvalues, whereas in females, the eigenvalue was 7.629 and 1.461, respectively, and the first variable accounted for 83.9 % of the total amount.

The absolute magnitudes of the standardized canonical discriminant coefficients are proportional to the relative importance of each character in separating the three species along each of the two canonical discriminant axes. In males, FL was the greatest contributor to separation on the first axis (2.766), followed by TL (2.764) and HLL (-2.651). On the second axis, LAL (1.220), HLL (-1.060) and IND (0.888) were the high contributors. Similarly, variables with high contribution on the first and second axes in females were LAL (-2.068), HLL (1.228) and TL (0.996), and TL (1.969), HL (-1.566) and HW (-0.930), respectively.

In males, *Rana* sp. from Sakhalin was nearly completely distinguishable from *R. pirica*, but completely overlapped *R. dybowskii* on the first canonical axis, while this situation reversed on the second canonical axis. Thus, on the first two axes, *Rana* sp. from Sakhalin was nearly completely distinguishable from *R. pirica*, and only slightly overlapped *R. dybowskii*. In this way, the intermediate position of *Rana* sp. from Sakhalin between *R. pirica* and *R. dybowskii* was clear in males. Separation was better in females, and the three species did not overlap on these axes.

Reflecting the similarities of the three species in gross appearance, the DISCRIM succeeded in assigning only 85.7 % (72 of 84) in males and 85 4 % (35 of 41) in females of the individual specimens to correct home population (Table IV). In males, the DISCRIM correctly classified 83.9 % (26 of 31) of *Rana* sp. from Sakhalin, with 9.7 % (3 of 31) of other specimens classified as members of *R. dybowskii*, and 6.5 % (2 of 31) as *R. pirica*. On the other hand, in females, four of five (80.0 %) individuals of *Rana* sp. from Sakhalin were correctly classified and all the remaining specimens were classified as members of *R. dybowskii* with only a low posterior probability (48.1%).

DISCUSSION

Rana sp. from Sakhalin was first recorded from the southern part of the island in 1870 by DOBROTVORSKY and was identified as *R. temporaria*. Since then, the brown frog from Sakhalin, together with that from Hokkaido (= *R. pirica*), have long been considered to be conspecific with this European species (BOULENGER, 1886; STEJNEGER, 1907; NIKOLSKY, 1905, 1918; OKADA & KAWANO, 1923; OKADA, 1930, 1931; TERENT'EV & CHERNOV, 1949). However, it is now generally accepted that *R. temporaria* has $2n = 26$ chromosomes (WITSCHI et al., 1958) and its range does not extend to the Asian regions (FROST, 1985). By contrast, *Rana* sp. from Sakhalin is inferred to have $2n = 24$ chromosomes, like Chinese *R. chensinensis* and its allies including *R. pirica* (SETO, 1965; GREEN, 1983; WEI et al., 1990).

More recently, *Rana* sp. from Sakhalin and *R. pirica* have often been regarded as populations of *R. chensinensis* (KAWAMURA, 1962; OKADA, 1966, as a subspecies of *R. temporaria*; ORLOVA et al., 1977, FROST, 1985; KUZMIN et al., 1988), *R. dybowskii* (NAKAMURA & UÉNO, 1963, as a subspecies of *R. temporaria*; NAKAMURA & UÉNO, 1965, as a subspecies of *R. chensinensis*) or *R. semiplicata* (BANNIKOV et al., 1977). Of these, *R. chensinensis* was described from the Qinling Mountains of China (DAVID, 1875), which are geographically quite distant from Sakhalin or Hokkaido. On the other hand, *R. dybowskii* was described from near Vladivostok, Russia (GÜNTHER, 1876). From this pattern of distribution, the relationships of brown frogs from Sakhalin and Hokkaido were expected to be closer to *R. dybowskii* than to *R. chensinensis*, and recent studies of the Hokkaido population led to the description of *R. pirica* (MATSUI, 1991), leaving the taxonomic status of *Rana* sp. from Sakhalin undetermined.

Taxonomic status of *R. semiplicata* is little understood. The species was described by NIKOLSKY (1918) from two specimens possibly from Poltavka, Maritime Territory, and it was said to resemble *R. tsushimensis* and *R. amurensis*, both of which have $2n = 26$ chromosomes (ORLOVA et al., 1977). TERENT'EV & CHERNOV (1949) claimed that inaccuracies were contained in the original description, but from the description and figures of a type specimen, this species is not related either to *R. tsushimensis* or to *R. amurensis*, but seems to be synonymous with *R. dybowskii* (MATSUI, 1991). BANNIKOV et al. (1977) included the coastal region of Russia and Sakhalin within the distribution range of *R. semiplicata*, while ORLOVA et al. (1977) synonymized this species with *R. chensinensis*. MATSUI (1991) suggested that "*R. semiplicata*" from Sakhalin (BANNIKOV et al., 1977) was possibly conspecific with *R. pirica*.

Previous morphometric comparisons of *R. pirica* with *R. dybowskii*, *R. ornativentris*, and topotypic *R. chensinensis* (MATSUI, 1991; MATSUI et al., 1993) indicated the presence of great differentiation between *R. pirica* and *R. dybowskii*. However, the results of morphometric analyses shown above indicate that *Rana* sp. from Sakhalin is not completely identical to either *R. pirica* or *R. dybowskii*, but is morphometrically intermediate between them. This result contradicts the taxonomic treatments made by BANNIKOV et al. (1977) with regard the coastal and Sakhalin populations as conspecific, or the prediction made by MATSUI (1991) to associate the Sakhalin population with *R. pirica*.

As noted by MATSUI et al. (1993), morphological differentiation seems generally preceded by genetical differentiation among brown frogs of the *R. temporaria* group, and the presence of even a subtle morphological difference between any two local populations seems to suggest the possibility of their independent taxonomic status. Additional studies from various approaches, especially biochemical ones, are necessary to elucidate the taxonomic position of *Rana* sp. from Sakhalin, and such studies are now underway. On the other hand, *Rana* sp. from Sakhalin is distinct from *R. chensinensis* in the characteristic swelling of water in the oviduct during preservation, as are *R. dybowskii*, *R. pirica* and a population of *R. chensinensis* from northeastern China (the Hashima-frog) (MATSUI, 1991), and these forms seem to constitute a monophyletic group.

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APPENDIX I
SPECIMENS EXAMINED

The samples are stored at the Graduate School of Human and Environmental Studies, Kyoto University (KUHE) and in Sen TAKENAKA private collection (ST).

Rana sp. (n = 37). – Sakhalin, Russia: Uglegorsk (48°40'N, 133°54'E): KUHE 11613-11627, 11644-11649, 11657-11670, 11680, 14138.

Rana pirica (n = 71). – Hokkaido, Japan: (1) Niikappu-cho (42°22'N, 142°19'E): KUHE 13871, 13876-13883, 13889-13891, 13893-13901; (2) Rankoshi-cho (42°52'N, 140°36'E): KUHE 13825-13828, 13833-13834, 13836, 13840-13842, 13844; (3) Kamishihoro-cho (43°21'N, 143°12'E): KUHE 13141-13149, 13152-13154, 13156, 13158-13160; (4) Obihiro-shi (42°53'N, 143°11'E): KUHE 13745, 13747, 13750-13751, 13753-13755, 13758, 13760; (5) Tomakomai-shi (42°40'N, 141°36'E): KUHE 13845-13847, 13850-13852, 13854, 13857, 13859-13861, 13863-13866.

Rana dybowskii (n = 20). – Primorsk, Russia: Lazo (43°21'N, 144°04'E): KUHE 11721-11732; ST 01-02, 06-07, 09, 14, 16, 18.

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